

c1
cont. 11 the field emission electron source portion is provided in a drain
12 region of the field effect transistor portion; and a control voltage is applied to a
13 gate electrode of the field effect transistor portion to control a field emission
14 current from the field emission electron source portion, wherein the gate electrode
15 is positioned lower than the extraction electrode;

16 the drain region includes different impurity elements and includes at
17 least two wells having different impurity concentrations having symmetrical
18 impurity distributions; and

19 of the at least two wells, one well having a low impurity
20 concentration is provided around a circumference of the other well having a higher
21 impurity concentration.

c2 1 4. (Amended) A field emission type electron source device
2 comprising:

3 a field emission electron source portion including an extraction
4 electrode provided on a p-type silicon substrate via an insulating film and having
5 an opening portion at a position corresponding to a region where a cathode is
6 provided; and a cathode portion provided on the p-type silicon substrate and at a
7 position corresponding to the opening portion of the extraction electrode; and

8 an n-channel field effect transistor portion provided on the p-type
9 silicon substrate, corresponding to the field emission electron source portion,

10 wherein:

11 the field emission electron source portion is provided in a drain
12 region of the field effect transistor portion; and a control voltage is applied to a
13 gate electrode of the field effect transistor portion to control a field emission
14 current from the field emission electron source portion;

15 the gate electrode of the field effect transistor portion has a shape
16 such that a portion of the gate electrode nearer the drain region has a total width

C2
cont.

17 wider than a total width of a portion of the source electrode nearer the source
18 region; a part of the gate electrode is provided in such a manner as to cover an end
19 of the drain region; and the gate electrode is positioned lower than the extraction
20 electrode.

1 5. (Amended) A field emission type electron source device
2 comprising:

3 a field emission electron source portion including an extraction
4 electrode provided on a p-type silicon substrate via a first insulating film and
5 having an opening portion at a position corresponding to a region where a cathode
6 is provided; and a cathode portion provided on the p-type silicon substrate and at a
7 position corresponding to the opening portion of the extraction electrode; and

8 an n-channel field effect transistor portion provided on the p-type
9 silicon substrate, corresponding to the field emission electron source portion,

10 wherein:

11 the field emission electron source portion is provided in a drain
12 region of the field effect transistor portion; and a control voltage is applied to a
13 gate electrode of the field effect transistor portion to control a field emission
14 current from the field emission electron source portion, wherein the gate electrode
15 is positioned lower than the extraction electrode;

16 the drain region including at least two wells having different
17 impurity concentrations, a first of the at least two wells being provided around a
18 circumference of the second of the at least two wells;

19 a gate insulating film is provided between the gate electrode of the
20 field effect transistor and the p-type silicon substrate; the gate insulating film
21 includes a film thinner than the first insulating film, the first insulating film being
22 provided between the extraction electrode and the p-type silicon substrate; and the
23 gate insulating film is buried with the first insulating film.

c³ 1 7. (Amended) A field emission type electron source device
2 comprising:

3 a field emission electron source portion including an extraction
4 electrode provided on a p-type silicon substrate via an insulating film and having
5 an opening portion at a position corresponding to a region where a cathode is
6 provided; and a cathode portion provided on the p-type silicon substrate and at a
7 position corresponding to the opening portion of the extraction electrode; and

8 an n-channel field effect transistor portion provided on the p-type
9 silicon substrate, corresponding to the field emission electrode source portion,

10 wherein:

11 the field emission electron source portion is provided in a drain
12 region of the field effect transistor portion; and a control voltage is applied to a
13 gate electrode of the field effect transistor portion to control a field emission
14 current from the field emission electron source portion;

15 the field emission type electron source device further comprises a
16 shield electrode made of the same material of that of the gate electrode of the field
17 effect transistor portion, and the shield electrode is provided in such a manner as to
18 cover a channel region of the field effect transistor portion which is not covered
19 with the gate electrode, while the potential of said shield electrode is made to be
20 equal to that of the substrate.

c⁴ 1 18. (Newly Added) A field emission type electron source device
2 comprising:

3 a field emission electron source portion including an extraction
4 electrode provided on a p-type silicon substrate via an insulating film and having
5 an opening portion at a position corresponding to a region where a cathode is
6 provided; and a cathode portion provided on the p-type silicon substrate and at a
7 position corresponding to the opening portion of the extraction electrode; and

C4
cont. 8 an n-channel field effect transistor portion provided on the p-type
9 silicon substrate, corresponding to the field emission electron source portion,

10 wherein:

11 the field emission electron source portion is provided in a drain
12 region of the field effect transistor portion; and a control voltage is applied to a
13 gate electrode of the field effect transistor portion to control a field emission
14 current from the field emission electron source portion;

15 the drain region of the field effect transistor portion is provided in a
16 source region of the field effect transistor portion in such a way to be surrounded
17 by the source region; and

18 the gate electrode of the field effect transistor portion is positioned
19 symmetrical in a plane with respect to the cathode portion of the field emission
20 electron source portion and lower than the extraction electrode.

1 19. (Newly added) A field emission type electron source device
2 according to claim 18, wherein the drain region includes a p-type conductive layer.

1 20. (Newly added) A field emission type electron source device
2 according to claim 18, wherein an outer portion of the drain region contacts the
3 channel region of the field effect transistor portion; and the outer region of the
4 drain region and an inner portion of the source region have a shape of concentric
5 circles.

1 21. (Newly added) A field emission type electron source device
2 according to claim 18, wherein at least a part of the gate electrode provided
3 between the source region and the drain region has a shape of a symmetrical
4 circular arc.

1 22. (Newly added) A field emission type electron source device
2 according to claim 18, wherein first voltage V_{ex} applied to the extraction electrode
3 of the field emission electron source portion and second voltage V_g applied to the

C4

Cmt.

4

gate electrode of the field effect transistor portion have a relationship such that

5

 $V_g < V_{ex}$.